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Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

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April 4, 2001

Assistant Commissioner for Patents
Washington, D.C. 20231
U.S.A.

Sir:

Re: **United States Patent Application No. 09/809,218**
Filed: **March 16, 2001**
Title: **ADAPTIVE PERSONAL REPEATER**
Inventor(s): **David Bongfeldt, et al.**
Assignee: **DPS Wireless Inc.**
Our File: **9-15000-1US KD/bm**

Enclosed herewith for filing against the above-identified application, is the required certified copy of the priority application in this matter, i.e. Canadian Patent Application No. 2,323,881, as filed October 18, 2000.

Respectfully submitted,

K. Daniels

Kent Daniels
Reg. No. 44,206
Agent of Record
KD/bm

Encls.
As above

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This is to certify that the documents attached hereto and identified below are true copies of the documents on file in the Patent Office.

Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,323,881**, on October 18, 2000, by **DPS WIRELESS INC.**, assignee of David Bongfeld, Paul Simpson and Shane Young, for "Adaptive Personal Repeater".

S. Grégoire

Agent certificateur/Certifying Officer

March 16, 2001

Date

Canada

(CIPO 68)
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OPIC CIPO

ADAPTIVE PERSONAL REPEATER

TECHNICAL FIELD

The present application relates to wireless access networks, and in particular to an adaptive personal repeater for enabling a wireless services subscriber to improve wireless services within a personal wireless space.

BACKGROUND OF THE INVENTION

On-frequency repeaters are known in the are for improving wireless services within defined regions of a wireless network (e.g. within a building or a built-up area). Such on-frequency repeaters are typically provided by the wireless network provider in order to improve signal quality in high noise or attenuation environments, where signal quality would otherwise be too low for satisfactory quality of service. In some cases, a wireless network provider may install a repeater in order to improve service in an area lying at an edge of the coverage area serviced by a base station, thereby effectively extending the reach of the base-station.

Prior art repeaters are part of a network-centric view of the wireless network space, in that they are comparatively large systems provided by the network provider in order to improve wireless service to multiple subscribers within a defined area. As such, they form part of the network "build-out plan" of the network provider. These systems suffer the disadvantage that an individual subscriber cannot benefit from the improves services afforded by the repeater unless they happen to be located within the coverage area of the repeater. However, there are many instances in which wireless subscribers may be located beyond the coverage area of wireless network.

Typical examples include mobile subscribers, and subscribers in rural areas. In such cases, it may be uneconomical for a network provider to build-out the network to provide adequate coverage area, thereby leaving those subscribers with inadequate wireless services.

Accordingly, a method and apparatus that enables cost-effective delivery of high quality wireless communications services to individual subscribers, independently of a location of the subscriber, remains highly desirable.

SUMMARY OF THE INVENTION

An Object of the present invention is to provide an apparatus that enables cost-effective delivery of high quality wireless communications services to individual subscribers, independently of a location of the subscriber

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will become apparent from the following detailed description, taken in combination with the appended drawings, in which:

Fig. 1 is a block diagram schematically illustrating principle elements and operations of a personal adaptive repeater in accordance with the present invention; and

Fig. 2 is a schematic diagram illustrating principle elements in an exemplary personal adaptive repeater in accordance with an aspect of the present invention.

It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

SUBSCRIBER-CENTRIC TECHNOLOGY

Subscriber-centric technology (SCT) refers to the concept of focusing the product/technology specifically towards the needs of the individual user or subscriber as opposed to the requirements of the network (i.e., network-centric).

The SCT concept, as embodied in the Adaptive Personal Repeater, complements existing wireless wide-area networks such as cellular and PCS by providing a cost-effective product solution for the individual subscriber who has inadequate or non-existent wireless coverage. Wireless infrastructure (e.g., base stations) is typically built out using a network-centric approach. The build out would begin with major metropolitan service areas (MSA) using base stations located at the center of overlapping "cells" as per the cellular concept. Eventually the build out and the corresponding wireless service migrate to areas of lower and lower population/service densities (e.g., urban to suburban to rural, etc.). At some point, dictated by economics, the build-out slows or becomes spotty leaving many individual wireless subscribers with unreliable or non-existent service. The Adaptive Personal Repeater allows the wireless subscriber to access the wireless network by reaching back from the outside of the network in without the need for any further network-centric build out. This technology is truly unique in that now the wireless

subscriber has the means to address poor or non-existent coverage when they need it or want it and thereby empowers the individual subscriber to manage their own "personal wireless space".

ADAPTIVE COVERAGE BREATHING

Adaptive Coverage Breathing (ACB) refers to the concept of RF power management that allows the subscriber's personal wireless space to "breath" by adaptively expanding and contracting to the subscriber's position within their own personal wireless space.

This ACB concept allows the Adaptive Personal Repeater to radiate only the necessary power needed to create a reliable personal wireless space for the subscriber. As the subscriber moves about their dwelling and/or property, their personal wireless space changes in coverage area by continuously adapting to their every movement. A subscriber moving towards the APR would automatically cause the coverage area to contract ensuring that the personal wireless space is confined to only that subscriber. This is accomplished by measuring the uplink receive power from the handset then adjusting the downlink transmit power accordingly. If two or more subscribers make calls simultaneously then the coverage area expands to the subscriber furthest from the APR. This is achieved by measuring the uplink receive power from the handsets then adjusting the downlink transmit power to account for the difference in the two or more receive power levels of the handsets. On the network side, the RF power management will easily allow the APR to sustain a reliable link with the base station since the propagation environment is fairly static due to the fixed locations of the base station and the APR. This is achieved by measuring the

downlink receive power from the base station then adjusting the uplink transmit power of the APR. If the receive power level is greater than the minimum acceptable level, then the transmit power can be reduced to improve spectrum efficiency, conserve energy, increase reliability and reduce system gain.

Two major benefits for the subscriber resulting from the ACB concept are reduced handset RF radiation and increased battery efficiency.

- Reduced RF Radiation: Reduced RF radiation for the subscriber is a major benefit, because until now subscribers have been faced with the growing concern that high level RF radiation in close proximity may be hazardous to human health. The RF power radiation of the handset can be significantly reduced since the APR now radiates all the high level RF power outside the subscriber's personal wireless space and dwelling.

- Increased Handset Talk Time: Subscribers are always faced with having to charge their handset battery on a regular basis, and not always are they in a position to do so when their batteries require charging. As a result, service providers and OEMs are always searching for ways to improve battery efficiency of the handsets. To that end, the single most power consuming section in the handset is the output amplifier. This amplifier is biased class A, B or C to consume battery power proportional to the RF input signal level, i.e. a large RF input signal

will cause the amplifier to consume a large amount of battery power to produce the necessary RF power via the antenna. The APR significantly increases the talk time of the handset by lowering RF output requirements of the handset.

ADAPTIVE INTERFERENCE MITIGATION (AIM)

Adaptive Interference Mitigation refers to the concept of mitigating interference in the subscriber's personal wireless space through the use of Adaptive Personal Repeaters, which may be viewed as a class of Smart Antenna Technology.

Interference has become a problem in most wireless service networks. The type and degree of interference varies from one network to the other. Smart antenna technology has been used in a wide variety of applications to combat interference in these networks. To date, applications have focused on smart antenna technology at the base station to solve the interference problem for both the downlink (interference to the handset from other base stations) and the uplink (interference to the base station from other handsets) communication paths. Until now, there has been no smart antenna technology that mitigates the interference at the handset end of the network. This is largely due to the size and power constraints of the handset and the requirement that the handset must be omni-directional to successfully connect and communicate to the base station in a wide area network.

The APR provides a means to mitigate the interference at the handset end of the network for both the downlink and the uplink propagation paths. Inherently, the APR wirelessly transforms the handset's omni-directional antenna pattern into a directional antenna pattern by

masking over in a specific direction the weak desired signal with a strong conditioned signal. Also, the ACB concept adaptively provides constant interference mitigation within the subscriber's personal wireless space, and also minimizes any possible interference that may be generated by confining the size of the personal wireless space to only the subscriber's position.

Directional antennas radiate RF energy in one direction more than in other directions. The APR uses an external directional antenna to reach back into the network and radiate RF power to the base station from outside the subscriber's personal wireless space. By virtue of the directionality of the antenna, the subscriber's personal wireless space not only can discriminate against interference coming from outside the antenna's beam-width, but also can prevent generating possible interference to other base stations in other directions. This in itself passively mitigates the interference in both the downlink and uplink paths. The antenna's discrimination provides the means to spatially separate the desired signal from possible sources of interference from other base stations. With this discrimination in hand, the APR then amplifies and conditions the desired signal and adaptively transmits it using the ACB concept to ensure that at the handheld, the desired signal remains constant in level regardless of the subscriber's position or movement. Unlike conventional mitigation schemes where the interference is reduced relative to the desired signal, here the desired signal outside the subscriber's personal wireless space is increased in level relative to the interference within the subscriber's personal wireless space; this in essence is the mitigation technique.

FUNCTIONAL ELEMENTS OF THE PRESENT INVENTION INCLUDE:

A WIDEBAND, HIGH DYNAMIC RANGE, ULTRA-FAST RF AUTOMATIC GAIN CONTROL (AGC)

On-frequency repeaters can potentially oscillate if the system gain exceeds the antenna isolation. For this reason and depending on the required link performance, installation can be very difficult. The AGC of the present invention operates over the system bandwidth, has a high dynamic range to allow for large antenna isolation variations and is ultra-fast to adjust the system gain in the event of instantaneous feedback. This addresses not only the possibility of oscillation during installation, but ensures that the spectrum never becomes contaminated during operation.

A DIGITAL OFFSET CORRECTION METHOD EMPLOYING NARROWBAND DETECTION AS A MEANS TO OFFSET THE WIDEBAND AGC LEVELING ACTION

The digital offset correction method enables the output of a wideband AGC to be set for signals that have not captured the AGC. A wideband AGC will level to the highest signal that captures the AGC within a defined bandwidth. If no signals are present, the AGC will level to the thermal and system noise of a given bandwidth. If weak signals are present and the AGC bandwidth is much larger than the signal bandwidth such that the noise masks the weak signals, then the AGC will be captured by the noise rather than the weak desired signal. In this case, narrowband detection can be used as a means to detect only the weak desired signal by filtering out the noise, which in turn can be used by a software control algorithm to offset the output to which the AGC levels. As well, this same technique can be applied to high-level unwanted

signals that capture the AGC and limit the system gain for the low level desired signal.

A MAXIMUM ACHIEVABLE ISOLATION OF CLOSELY SPACED ANTENNAS BY MINIMIZING FREE SPACE COUPLING USING CROSS POLARIZATION, BEAM SWITCHING AND ANTENNA BEAM STEERING TECHNIQUES FOR BOTH IN-BUILDING AND IN-VEHICLE APPLICATIONS

In any communication network, the link distances are defined by the allowable receive and transmit power levels. The same holds true for the setup of adaptive repeaters, hence the minimum receive power level and the maximum transmit power level in both directions, ultimately determines the maximum system gain required for each direction. A fundamental limitation of on-frequency repeaters is that maximum gain is usually limited by the isolation between its antennas due to their proximity. By maximizing the isolation between closely spaced antennas, the available system gain can be utilized to achieve the required link distances. Techniques such as cross-polarization, beam switching and antenna beam steering can be exploited to increase the isolation between closely spaced antennas. These techniques together with the design of high performance antennas will help satisfy the isolation requirements.

IMPLEMENTING A MAXIMAL COMBINING TECHNIQUE USING ANTENNA BEAM SWITCHING TO COMBAT A SEVERELY FADED MOBILE ENVIRONMENT FOR IN-VEHICLE APPLICATIONS

Almost all received signals have more than one path associated with their reception; this is known as multi-path reception. The received signal may come from a direct and/or indirect path depending on the propagation environment. Sources that change position, or have reflective objects that move close to the point of reception, will cause a fading effect of the received

signal. A faded signal changes amplitude and phase with time relative to a stationary signal. Faded mobile signals change amplitude and phase at a rate proportional to the speed of the mobile. The type of fading (e.g. Rayleigh or Rician) depends on the number and type of multi-paths, i.e. the number of direct and/or indirect paths. Severely faded signals can cause what appears to be loss of coverage due to a significant reduction in received power level. As well for both narrowband and broadband digital signal formats, large phase changes can cause distortion in the form of inter-symbol errors. It is proposed that the AMR will use two or more low-cost antennas in a diversity configuration. Antennas that are spacially separated by a minimum spacing of at least one wavelength will exhibit some de-correlation of a given signal at the same time. The received signal from the base station in the downlink … and as a reciprocal effect, the transmit signal in the uplink can be maximized in a severely faded signal environment by employing maximal combining via antenna beam switching.

A SOFTWARE CONTROL ALGORITHM, RUNNING ON A LOW-COST EMBEDDED MICRO-CONTROLLER, THAT WILL ENABLE THE ADAPTIVE REPEATER TO ADAPTIVELY MINIMIZE THE TRANSMIT POWER IN BOTH DIRECTIONS

The software control algorithm is the control process behind the operation of the adaptive repeaters. By power managing the output of both antennas, the APR and AMR products can adaptively minimize the transmit power in both directions. This concept is called Adaptive Cell Breathing (ACB); it allows the adaptive repeater to radiate only the necessary power needed to create a reliable personal wireless space for the subscriber. As the subscriber moves about their dwelling and/or property, their personal wireless space changes in coverage area by continuously

adapting to their every movement. A subscriber moving towards the adaptive repeater would automatically cause the coverage area to contract ensuring that the personal wireless space is confined to only that subscriber. This is accomplished by measuring the uplink receive power from the handset then adjusting the downlink transmit power accordingly. On the network side, the software control algorithm manages the RF power to sustain a reliable link with the power of the adaptive repeater.

USING AN ADAPTIVE REPEATER TO CREATE AND MANAGE THE "PERSONAL WIRELESS SPACE" OF A SUBSCRIBER IN TERMS OF LOWER RF HANDSET POWER AND REDUCED BATTERY CONSUMPTION, BOTH QUANTITATIVELY AND QUALITATIVELY

Two major benefits for the subscriber resulting from the ACB concept are reduced RF radiation and increased battery life of the handset. Reduced RF radiation for the subscriber is a major benefit, because until now subscribers have been faced with the growing concern that high level RF radiation in close proximity may be hazardous to human health. The RF power radiation of the handset can be significantly reduced since the adaptive repeater now radiates all the high level RF power outside the subscriber's personal wireless space and dwelling. By lowering the RF output requirements of the handset, the adaptive repeater can significantly increase the battery life of the handset. Subscribers are always faced with having to charge their handset battery on a regular basis and not always are they in a position to do so when their batteries require charging, which ultimately means loss of revenue for the service provider. As a result, service providers and OEMs are always searching for ways to improve the battery life of the handsets.

INTERFERENCE MITIGATION AFFORDED BY THE USE OF AN ADAPTIVE PERSONAL REPEATER WHICH EFFECTIVELY TRANSOFRMS AN OMNI-DIRECTIONAL RADIATION PATTERN OF A HANDSET INTO A HIGH-GAIN, DIRECTIONAL AND STEERED PATTERN

Interference has become a problem in most wireless service networks. The type and degree of interference varies from one network to the other. Smart antenna technology has been used in a wide variety of applications to combat interference in these networks. To date, applications have focused on smart antenna technology at the base station to solve the interference problem for both the downlink (interference to the handset from other base stations) and the uplink (interference to the base station from other handsets) communication paths. Until now, there has been no smart antenna technology that mitigates the interference at the handset end of the network. This is largely due to the size and power constraints of the handset and the requirement that the handset must be omni-directional to successfully connect and communicate to the base station in a wide area network. The APR provides a means to mitigate the interference at the handset end of the network for both the downlink and the uplink propagation paths. Inherently, the APR wirelessly transforms the handset's omni-directional antenna pattern into a directional antenna pattern by masking in a specific direction the weak desired signal with a strong conditioned signal. Also, the ACB concept adaptively provides constant interference mitigation within the subscriber's personal wireless space, and also minimizes any possible interference that may be generated by confining the size of the personal wireless space to only the subscriber's position from the APR. Directional antennas radiate RF energy in one direction more than in other directions. The

APR uses an external directional antenna to reach back into the network and radiate RF power to the base station from outside the subscriber's personal wireless space. By virtue of the directionality of the antenna, the subscriber's personal wireless space cannot only discriminate against interference coming from outside the antenna's beam-width, but can prevent generating possible interference to other base stations in other directions. This in itself passively mitigates the interference in both the downlink and uplink paths. The antenna's discrimination provides the means to spatially separate the desired signal from possible sources of interference from other base stations. With this discrimination in hand, the APR then amplifies and conditions the desired signal and adaptively transmits it using the ACB concept to ensure that at the handheld, the desired signal remains constant in level regardless of the subscriber's position or movement. Unlike conventional mitigation schemes where the interference is reduced relative to the desired signal, here the desired signal outside the subscriber's personal wireless space is increased in level relative to the interference within the subscriber's personal wireless space; this in essence is the mitigation technique.

SYSTEM BLOCK DIAGRAM OVERVIEW

The adaptive Personal Repeater, referred to hereafter as the APR as depicted in the System Block Diagram consists of an outdoor directional donor unit (DDU) connected via a single 30 m length of coaxial cable to an indoor directional coverage unit (DCU). The DDU links the APR to the cellular base station via a wireless propagation path, which attenuates the cellular signal with increasing distance. The system design provides for complete APR functionality over a wide range of receive and transmit

power levels. The DDU can accept receive power levels varying from -60 dBm to -120 dBm. It can transmit a maximum EIRP to the base station of +39 dBm, which is expected to be greater than 20 dB above the indoor cellular handset's transmit power. This can alone increase a given coverage area by ten times. The DCU creates the subscriber's personal wireless space by maintaining constant transmit power at the subscriber and accepting a wide variation of receive power from the handheld. Because the subscriber may be anywhere from 1 to 30 m from the DCU, both inside and outside their premises, the variation in received power may be as high as 50 to 60 dB. The DCU can accept receive power levels varying from 0 dBm to -60 dBm. It can transmit a maximum EIRP to the subscriber of -20 dBm.

DIRECTIONAL DONOR UNIT

The Directional Donor Unit is a single port active antenna, comprised of a directional donor antenna (DDA) integrated with a transceiver diplexer (TRD). Port, P1 is a bi-directional, and must receive and transmit simultaneously both cellular frequency bands. It accepts the DCU uplink transmit frequency band from 824 to 849 MHz and provides the DCU downlink receive frequency band from 869 to 894 MHz. Internally, P1 is divided into two separate RF signal paths in the TRD, the Downlink Path and the Uplink Path. The diplexers not only divide and combine each path, but they define and limit the frequency bandwidth to which the system must maintain stability.

DIRECTIONAL DONOR ANTENNA AND TRANSCEIVER DIPLEXER

The DDA is a positional, high performance, vertically polarized, directional antenna. The DDA is positional in the horizontal plane to allow for

alignment to the base station during installation. The directionality of the antenna will help to fine tune the positioning. The vertical polarization maximizes the coupling to the vertical EM field radiated from the base station. The DDA transmits the uplink and receives the downlink 800 MHz cellular signal(s). An antenna gain of 12 dBi will be required to transmit in the uplink path a maximum EIRP of +39 dBm. By incorporating the driver stage and the power amp (PA) section into the DDU, hence minimizing the loss between the PA and the antenna, the output requirements of the PA are significantly reduced. In fact, the TRD PA's output power, which is enabled and disabled automatically by a simple detection circuit, is lower than the RF output power of a cellular handset. This improves performance, power consumption, reliability and lowers cost. The diplexers' isolation must prevent the PA in the uplink path from saturating the LNA in the downlink path. This isolation is critical since the transmit power from the PA into the diplexer can be as high as +30 dBm. The LNA is a high performance device providing 15 dB of gain with a noise figure of 1.5 dB. It sets the noise figure of the downlink path, including the loss of the diplexer, to less than 5 dB with the AGC at maximum gain. The DDA gain together with the noise figure and the gain of the LNA section in the downlink path will determine the minimum signal strength and quality (i.e. the S/N ratio) of the received cellular signal(s). A minimum receive signal of -120 dBm in a 25 kHz noise bandwidth at the input of the DDA

will produce a S/N ratio of +17 dB at the output of P1, excluding any environmental noise. The SAW BPF after the LNA rejects the image noise and further attenuates the uplink transmit signal in the downlink path. The amplifier between the SAW filter and the diplexer is used as a buffer and gain stage to compensate for the coaxial cable loss. Because the coaxial cable loss is high, it is necessary to further amplify the receive signal before the loss to preserve the S/N ratio. The total gain of the APR is the combined gain of the DDU and DCU, and will most likely be limited by the isolation between the units achieved during installation. To help maximize the isolation between the two units and therefore achieve the required gain to maintain reliable links, the DDA must have a front to back ratio of greater than 25 dB.

DIRECTIONAL COVERAGE UNIT

The Directional Coverage Unit is a single port active antenna, comprised of a directional coverage antenna (DCA) integrated with a dual-directional processor (DDP). Port P2 is bi-directional, and must receive and transmit simultaneously both cellular frequency bands. It accepts the DDU downlink receive frequency band from 869 to 894 MHz and provides the DDU uplink transmit frequency band from 824 to 869 MHz. Internally, P2 is divided into two separate RF signal paths in the DDP, the Downlink Path and the Uplink Path. Each path is amplified, conditioned, and processed separately to ensure optimum performance for each link. The diplexers define and limit the frequency bandwidth to which the system must maintain stability.

DIRECTIONAL COVERAGE ANTENNA

The DCA is a positional, wide beam-width, horizontally polarized, directional antenna. The vertical positioning provides a mechanism to improve the antenna isolation and optimize the APR gain. The wide beam-width ensures adequate forward coverage to create a bubble-effect for the personal wireless space. Horizontal polarization creates an orthogonal relationship to the DDA polarization, which improves the isolation between the antennas. Also, the antenna's front to back ratio of greater than 20 dB will help add to the system isolation. The DCA transmits the downlink and receives the uplink 800 MHz cellular signal(s). An antenna gain of 6 dBi is required to radiate in the downlink path a maximum EIRP of -20 dBm. The EIRP minus the antenna gain determines the output of the DDP, which is -26 dBm.

DUAL-DIRECTIONAL PROCESSOR

The dual-directional processor (DDP) is a combined RF and digital processing module. Both the RF downlink path (881 MHz) and uplink path (836 MHz) are amplified, conditioned and processed separately over the entire 25 MHz of bandwidth. This processing scheme improves performance while reducing complexity, thus lowering the product cost. The DDP is comprised of two separate wideband AGCs, a common switched down-converter and narrowband detector, a single tunable fractional-N synthesizer and a digital processor. The diplexers define and limit the frequency

bandwidth to which the system must maintain stability. The total system isolation including the antennas' front to back ratios, polarization coupling and propagation path loss between the antennas must be greater than the maximum combined gain of the DDP and the TRD including cable loss in either direction to maintain an unconditionally stable system. System stability within the defined bandwidth will be maintained by the AGC action and adaptively adjusting the hardware gain independently so as to minimize the transmit power in both directions under the control of a software algorithm. A reduction in gain as a result of insufficient isolation will reduce the coverage areas in both directions, thus limiting the effectiveness of the APR to maintain reliable links in both directions.

The DDP downlink path receives, processes and transmits the entire 869 to 894 MHz cellular frequency band. This path consists of a pre-amplifier, AGC and output amplifier stage, all of which are cascaded with inter-stage filters, and connected at each end with a diplexer. The pre-amplifier preserves the S/N ratio established by the LNA in the TDR, and buffers the diplexer from the first SAW BPF in the chain. The SAW BPF together with the diplexer helps limit the downlink bandwidth to 25 MHz, rejecting the image noise and any out-of-band signals, including the uplink transmit signal(s). The AGC is an extremely fast, wide dynamic range, highly linear block consisting of a single VGA stage, inter-stage amplifiers and filters, two

directional couplers and a combined RF and IF log amp detection feedback section. The VGA has 60 dB of gain variation, and is cascaded with fixed gain blocks to enhance system linearity while minimizing the cascaded noise figure. The SAW BPFs after the VGA limit the VGA noise to 25 MHz and prevent out-of-band signals from capturing the AGC and saturating the output amplifier. The 17 dB directional couplers provide a sample of the VGA's output to the two log amps via an RF broadband and IF narrowband path. The first path, SP1 is a broadband path that is connected directly to the leveling log amp. This path is used to monitor the system stability and provide instantaneous RF AGC feedback over the 25 MHz of bandwidth. The AGC prevents the system from oscillating by automatically adjusting the gain in the downlink path in the event of inadequate isolation between the antennas. The second path, SP2 can be either terminated or switched to the common narrowband IF down-conversion stage. The down-converter is comprised of a tunable synthesizer, active mixer and selectable filter, which outputs 45 MHz with a defined 25 kHz bandwidth to the detection log amp. This path operates in parallel to the RF broadband path, and is used to detect weak desired signals that are below the -100 dBm noise floor for a 25 MHz bandwidth. It provides the means to digitally correct the AGC leveling via the micro-controller by offsetting the AGC leveled output to the weak desired signals. The downlink output amplifier increases the leveled received signal(s) to -26

dBm at the diplexer's output. The AGC gain can be forced lower via the micro-controller to maintain stability during setup, thereby ensuring the detection of weak desired signals without the need for initial maximization of system isolation.

The DDP uplink path receives, processes and transmits the entire 824 to 849 MHz cellular frequency band. This path consists of an AGC and an output amplifier stage, all of which are cascaded with inter-stage filters, and connected at each end with a diplexer. The AGC, similar to the downlink AGC is an extremely fast, wide dynamic range, highly linear block consisting of a single VGA stage, inter-stage amplifiers and filters, two directional couplers and a combined RF and IF log amp detection feedback section. The VGA has 60 dB of gain variation, and it is positioned before the cascaded fixed gain blocks to enhance system linearity. This is important, because the received uplink signals are much greater than the received downlink signals. The SAW BPFs after the VGA limit the VGA noise to 25 MHz and prevent any out-of-band signals from capturing the AGC and saturating the output amplifier. The 17 dB directional couplers provide a sample of the VGA;s output to the two log amps via an RF broadband and IF narrowband path. The first path, SP4 is a broadband path that is connected directly to the leveling log amp. This path is used to monitor the system stability and provide instantaneous RF AGC feedback over the 25 MHz of bandwidth. The AGC prevents the system from oscillating by automatically adjusting the

gain in the uplink path in the event of inadequate isolation between the antennas. The second path, SP3 is a narrowband path that can be either terminated or switched to the common IF down conversion stage. When switched to the common down-converter, this path can be used to detect the channel of the cellular phone in the uplink; hence this information can be used to tune the synthesizer to the corresponding channel in the downlink. The uplink output amplifier increases the output of the DDP to -3 dBm at the diplexer's output.

The digital processor consists of a micro-controller, a software control algorithm, analog to digital converters (ADCs), and digital to analog converters (DACs). The micro-controller reads and writes to the analog hardware via the ADCs and DACs through the execution of a software control algorithm. The software control algorithm provides the necessary processing control for the APR to operate as a stand-alone unit without intervention after the installation. Also, the software control algorithm is key to simplifying the installation and providing the adaptive means to power manage the network. The ADCs provide digital inputs to the micro-controller by converting the detected RF and IF signals from the log amps. The software control algorithm uses these inputs to make decisions by comparing the readings to defined threshold levels. The DACs accept digital outputs from the micro-controller and converts them to an analog signal to set the operating point of the log amps. The software

control algorithm uses these outputs to set the gain and leveling of the AGC for both the uplink and the downlink paths.

The configuration switch allows the subscriber to set certain conditions within the software control algorithm. The subscriber can set the algorithm to remain in setup mode, thereby allowing time to adjust the placement and positioning of the DDU and DCU. Also, the two carrier bands to which the APR will operate over can be selected together or individually. As well, the subscriber can choose to limit the DCA;s coverage area by setting the configuration switch to lower the downlink gain.

The embodiment(s) of the invention described above is(are) intended to be exemplary only. The scope of the invention is therefore intended to be limited solely by the scope of the appended claims.

I/WE CLAIM:

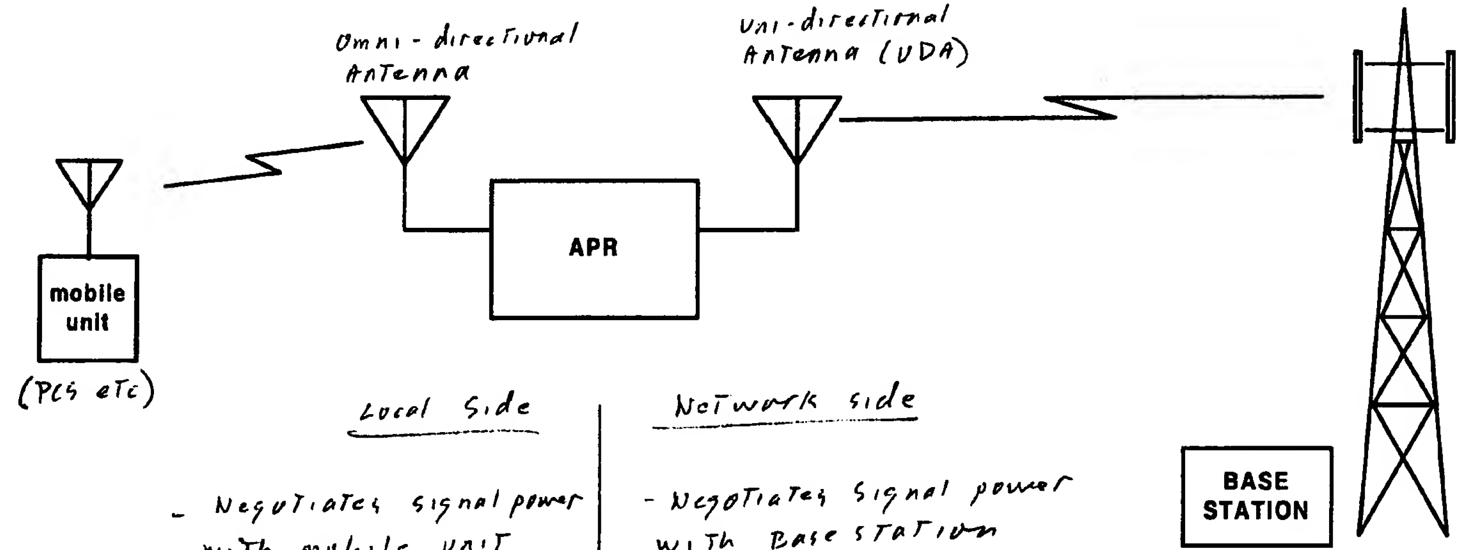
1. An adaptive repeater for use in a wireless network, the adaptive repeater comprising:
   a) a unidirectional antenna adapted maintain a bi-directional wireless link with a base station of the wireless network;
   b) an omnidirectional antenna adapted to maintain a bi-directional wireless link with a mobile unit;
   c) power management means for negotiating a network side signal power for signaling between the unidirectional antenna and the base station independently of a local side signal power for signaling between the omnidirectional antenna and the mobile unit.

2. An adaptive repeater as claimed in claim 1, wherein the power management means is adapted to minimize the local side signal power, whereby a local-side coverage area is dynamically adjusted in accordance with a location of the mobile unit.

3. An adaptive repeater as claimed in claim 1, further comprising means for adaptively mitigating interference at the mobile unit due to network-side signaling.

4. An adaptive repeater as claimed in claim 1, further comprising means for adaptively mitigating interference at the base station due to local-side signaling.

Fig 1



Local Side	Network side
- Negotiates signal power with mobile unit - coverage area of APR automatically adjusts for location of mobile unit (Adaptive Coverage Breathing)	- Negotiates signal power with Base station - use of ~~the~~ UDA and greater signal power (Than mobile unit) provides ~~more~~ increased signal reach and improved service quality Than is possible without APR. - UDA mitigates both up-link and down-link interference on network side, since it will only send/receive signals To/from a Base station within its beam path This can be narrowly focused

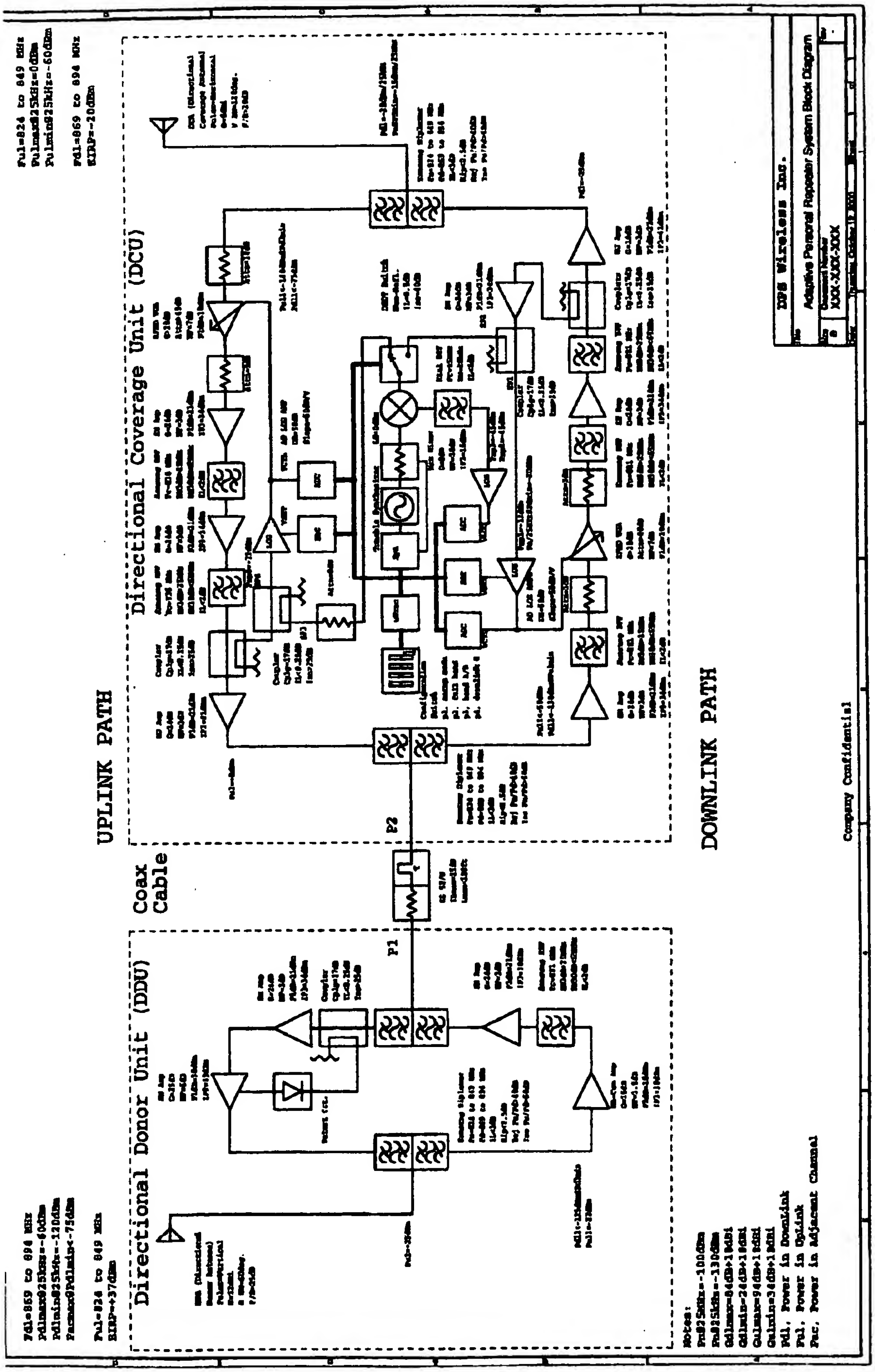

Directional Coverage Unit (DCU)
UPLINK PATH
DOWNLINK PATH
Coax Cable
P1
P2
Directional Donor Unit (DDU)
DPS Wireless Inc.
Adaptive Personal Repeater System Block Diagram
XXX-XXX-XXX
Company Confidential
Notes:
Pdl, Power in Downlink
Pul, Power in Uplink
Pac, Power in Adjacent Channel

Fig 2